DESIGN LIFE FOR ROLLING BEARINGS, HOURS[12.4]

TYPE OF SERVICE	HOURS (90% *life*)
Infrequent use—instruments, demonstration apparatus, sliding doors	500
Aircraft engines	500 to 2000
Intermittent use, service interruptions of minor importance—hand tools, hand-driven machines, farm machinery, cranes, household machines	4000 to 8000
Intermittent use, dependable operation important—work moving devices in assembly lines, elevators, cranes, and less-frequently used machine tools	8000 to 12,000
8-hour service, not fully utilized—gear drives, electric motors	12,000 to 20,000
8-hour service, fully utilized—machines in general, cranes, blowers, shop shafts	20,000 to 30,000
24-hour service, continuous operation—separators, compressors, pumps, conveyor rollers, mine hoists, electric motors	40,000 to 60,000
24-hour service, dependable operation important—machines in continuous-process plants, such as paper, cellulose; power stations, pumping stations, continuous service machines aboard ships	100,000 to 200,000

TABLE 12.3
SINGLE-ROW, DEEP-GROOVE BALL BEARINGS

From Ref. *(12.14)*. Basic dynamic load rating F_r is for 1 million revolutions (mr); 90% of a group of bearings should last longer than 1 mr. with the rated loads given. The speed limit given is approximate for oil bath lubrication; for grease, use $\frac{3}{4}$ of these values. More detail in catalogs. Factors limiting speed include lubrication, fit, dynamic balance, vibration. It is possible to exceed the specified limits.[12.16] Higher speeds can be obtained by oil mist lubrication, by circulating and cooling the oil, or by cooling the bearing. Consult manufacturers.

BRG. NO.	200 SERIES (200–222)					300 SERIES (300–322)				200
	Balls		*Static*	*Rated*	*Speed*	*Balls*		*Static*	*Rated*	*Roller*
	No.	*Dia.*	F_s, lb.	F_r, lb. 1 mr.	*Limit* rpm	*No.*	*Dia.*	F_s, lb.	F_r, lb. 1 mr.	F_r 1 mr.
00	7	$\frac{3}{16}$	440	805	25,000	6	$\frac{9}{32}$	845	1,400	
01	7	$\frac{13}{64}$	685	1,180	23,000	6	$\frac{5}{16}$	1,040	1,680	
02	8	$\frac{13}{64}$	790	1,320	20,000	7	$\frac{5}{16}$	1,220	1,960	
03	8	$\frac{17}{64}$	1,000	1,650	18,000	7	$\frac{11}{32}$	1,470	2,340	
04	8	$\frac{5}{16}$	1,390	2,210	15,000	7	$\frac{3}{8}$	1,750	2,750	
05	9	$\frac{5}{16}$	1,560	2,420	13,000	7	$\frac{7}{16}$	2,390	3,660	2,980
06	9	$\frac{3}{8}$	2,250	3,360	11,000	8	$\frac{21}{64}$	3,340	4,850	3,970
07	9	$\frac{7}{16}$	3,070	4,440	9,400	8	$\frac{17}{32}$	4,020	5,750	5,900
08	9	$\frac{15}{32}$	3,520	5,040	8,400	8	$\frac{19}{32}$	5,020	7,040	7,670
09	9	$\frac{1}{2}$	4,010	5,660	7,700	8	$\frac{11}{16}$	6,730	9,120	8,070
10	10	$\frac{1}{2}$	4,450	6,070	7,100	8	$\frac{3}{4}$	8,010	10,700	8,440
11	10	$\frac{9}{16}$	5,630	7,500	6,500	8	$\frac{13}{16}$	9,400	12,400	10,300
12	10	$\frac{5}{8}$	6,950	9,070	5,900	8	$\frac{7}{8}$	10,900	14,100	12,600
13	10	$\frac{21}{32}$	7,670	9,900	5,400	8	$\frac{15}{16}$	12,500	16,000	14,900
14	10	$\frac{11}{16}$	8,410	10,800	5,100	8	1	14,200	18,000	14,800
15	11	$\frac{11}{16}$	9,250	11,400	4,800	8	$1\frac{1}{16}$	16,100	19,600	18,200
16	10	$\frac{3}{4}$	10,000	12,600	4,500	8	$1\frac{1}{8}$	18,000	21,300	19,600
17	11	$\frac{23}{32}$	12,000	14,400	4,200	8	$1\frac{3}{16}$	20,100	22,900	22,400
18	10	$\frac{7}{8}$	13,600	16,600	3,900	8	$1\frac{1}{4}$	22,300	24,700	28,600
19	10	$\frac{15}{16}$	15,600	18,800	3,700	8	$1\frac{5}{16}$	24,500	26,400	31,400
20	10	1	17,800	21,100	3,500	8	$1\frac{7}{16}$	29,400	29,900	34,800
21	10	$1\frac{1}{16}$	20,100	23,000	3,300	8	$1\frac{1}{2}$	32,000	31,800	
22	10	$1\frac{1}{8}$	22,500	24,900	3,100	8	$1\frac{3}{8}$	37,600	35,400	46,200

judgment. For example, for *shafts connected by gears*, multiply the computed values of F_e by a service factor as follows:[12.4]

Rotating machines, no impact; electric motors, rotary compressors, etc.,	1.1 to 1.5;
Reciprocating machines,	1.3 to 1.9;
Machines with pronounced impact, hammer mills, etc.,	1.6 to 4.

TABLE 12.4 DIMENSIONS OF ROLLING BEARINGS[12.4]

This table does not give all standard dimensions. The maximum fillet radius r is the maximum radius at the shoulder *on the shaft* which is cleared by the corner radius on the bearing. Conversion factors: 0.03937 in./mm.; 25.4 mm/in.

	BORE		OUTSIDE DIAMETER mm			WIDTH OF RACES, mm			MAX. FILLET r		
BRG. NO.	*mm.*	*in.*	200 *Series*	300 *Series*	400 *Series*	200 *Series*	300 *Series*	400 *Series*	200 *Series*	300 *Series*	400 *Series*
00	10	0.3937	30	35		9	11		0.024	0.024	
01	12	0.4724	32	37		10	12		0.024	0.039	
02	15	0.5906	35	42		11	13		0.024	0.039	
03	17	0.6693	40	47		12	14		0.024	0.039	
04	20	0.7874	47	52		14	15		0.039	0.039	
05	25	0.9843	52	62	80	15	17	21	0.039	0.039	0.059
06	30	1.1811	62	72	90	16	19	23	0.039	0.039	0.059
07	35	1.3780	72	80	100	17	21	25	0.039	0.059	0.059
08	40	1.5748	80	90	110	18	23	27	0.039	0.059	0.079
09	45	1.7717	85	100	120	19	25	29	0.039	0.059	0.079
10	50	1.9685	90	110	130	20	27	31	0.039	0.079	0.079
11	55	2.1654	100	120	140	21	29	33	0.059	0.079	0.079
12	60	2.3622	110	130	150	22	31	35	0.059	0.079	0.079
13	65	2.5591	120	140	160	23	33	37	0.059	0.079	0.079
14	70	2.7559	125	150	180	24	35	42	0.059	0.079	0.098
15	75	2.9528	130	160	190	25	37	45	0.059	0.079	0.098
16	80	3.1496	140	170		26	39		0.079	0.079	
17	85	3.3465	150	180		28	41		0.079	0.098	
18	90	3.5433	160	190		30	43		0.079	0.098	
19	95	3.7402	170	200		32	45		0.079	0.098	
20	100	3.9370	180	215		34	47		0.079	0.098	
21	105	4.1339	190	225		36	49		0.079	0.098	
22	110	4.3307	200	240		38	50		0.079	0.098	

TABLE 12.2
THRUST FACTOR FOR DEEP-GROOVE, SINGLE- AND DOUBLE-ROW BALL BEARINGS

(F_a = *thrust load*; F_s = *basic static load rating*)

F_a/F_s	0.014	0.028	0.056	0.084	0.11	0.17	0.28	0.42	0.56
C_t	2.3	1.99	1.71	1.55	1.45	1.31	1.15	1.04	1.00
Q	0.19	0.22	0.26	0.28	0.30	0.34	0.38	0.42	0.44

FLEXIBLE POWER TRANSMITTING ELEMENTS

INCH OF WIDTH, LEATHER BELTS[17.9]

For belt speeds over 6000 fpm, consult a leather belting manufacturer; t is the average thickness of leather belting.

Belt Speed fpm	Single Ply $t = \frac{11}{64}$"	$\frac{11}{64}$"	Double Ply $\frac{15}{64}$"	$\frac{20}{64}$"	$\frac{22}{64}$"	Triple Ply $\frac{25}{64}$"	$\frac{28}{64}$"
	Med.	Heavy	Light	Medium	Heavy	Medium	Heavy
600	1.1	1.2	1.5	1.8	2.2	2.5	2.8
800	1.4	1.7	2.0	2.4	2.9	3.3	3.6
1000	1.8	2.1	2.6	3.1	3.6	4.1	4.5
1200	2.1	2.5	3.1	3.7	4.3	4.9	5.4
1400	2.5	2.9	3.5	4.3	4.9	5.7	6.3
1600	2.8	3.3	4.0	4.9	5.6	6.5	7.1
1800	3.2	3.7	4.5	5.4	6.2	7.3	8.0
2000	3.5	4.1	4.9	6.0	6.9	8.1	8.9
2200	3.9	4.5	5.4	6.6	7.6	8.8	9.7
2400	4.2	4.9	5.9	7.1	8.2	9.5	10.5
2600	4.5	5.3	6.3	7.7	8.9	10.3	11.4
2800	4.9	5.6	6.8	8.2	9.5	11.0	12.1
3000	5.2	5.9	7.2	8.7	10.0	11.6	12.8
3200	5.4	6.3	7.6	9.2	10.6	12.3	13.5
3400	5.7	6.6	7.9	9.7	11.2	12.9	14.2
3600	5.9	6.9	8.3	10.1	11.7	13.4	14.8
3800	6.2	7.1	8.7	10.5	12.2	14.0	15.4
4000	6.4	7.4	9.0	10.9	12.6	14.5	16.0
4200	6.7	7.7	9.3	11.3	13.0	15.0	16.5
4400	6.9	7.9	9.6	11.7	13.4	15.4	16.9
4600	7.1	8.1	9.8	12.0	13.8	15.8	17.4
4800	7.2	8.3	10.1	12.3	14.1	16.2	17.8
5000	7.4	8.4	10.3	12.5	14.3	16.5	18.2
5200	7.5	8.6	10.5	12.8	14.6	16.8	18.5
5400	7.6	8.7	10.6	12.9	14.8	17.1	18.8
5600	7.7	8.8	10.8	13.1	15.0	17.3	19.0
5800	7.7	8.9	10.9	13.2	15.1	17.5	19.2
6000	7.8	8.9	10.9	13.2	15.2	17.6	19.3

Minimum Pulley Diameters, Inches

up to 2500	$2\frac{1}{2}$	3	4	5*	8*	16**	20**
2500–4000	3	$3\frac{1}{2}$	$4\frac{1}{2}$	6*	9*	18**	22**
4000–6000	$3\frac{1}{2}$	4	5	7*	10*	20**	24**

* For belts over 8 in. wide, add 2 in. to the minimum diameters shown.
** For belts over 8 in. wide, add 4 in. to the minimum diameters

HORSEPOWER CONSTANTS[17.13]

See equation (1) for the constants a, c, e, for a B belt.
Minimum D_s is the smallest sheave pitch diameter that should be used with that section. If a smaller sheave is used, short belt life should be expected; L in inches.

A SECTION		B SECTION		C SECTION		D SECTION	
Min. D_s = 3 in.		Min. D_s = 5.4 in.		Min. D_s = 9 in.		Min. D_s = 13 in.	
Belt No.	Pitch Length	Belt No.	Pitch Length	Belt No.	Pitch Length	Belt No.	Pitch Length
A26	27.3	B35	36.8	C51	53.9	D120	123.3
A31	32.3	B38	39.8	C60	62.9	D128	131.3
A35	36.3	B42	43.8	C68	70.9	D144	147.3
A38	39.3	B46	47.8	C75	77.9	D158	161.3
A42	43.3	B51	52.8	C81	83.9	D173	176.3
A46	47.3	B55	56.8	C85	87.9	D180	183.3
A51	52.3	B60	61.8	C90	92.9	D195	198.3
A55	56.3	B68	69.8	C96	98.9	D210	213.3
A60	61.3	B75	76.8	C105	107.9	D240	240.8
A68	69.3	B81	82.8	C112	114.9	D270	270.8
A75	76.3	B85	86.8	C120	122.9	D300	300.8
A80	81.3	B90	91.8	C128	130.9	D330	330.8
A85	86.3	B97	98.8	C144	146.9	D360	360.8
A90	91.3	B105	106.8	C158	160.9	D390	390.8
A96	97.3	B112	113.8	C173	175.9	D420	420.8
A105	106.3	B120	121.8	C180	182.9	D480	480.8
A112	113.3	B128	129.8	C195	197.9	D540	540.8
A120	121.3	B144	145.8	C210	212.9	D600	600.8
A128	129.3	B158	159.8	C240	240.9	D660	660.8
		B173	174.8	C270	270.9		
		B180	181.8	C300	300.9		
		B195	196.8	C330	330.9		
		B210	211.8	C360	360.9		
		B240	240.3	C390	390.9		
		B270	270.3	C420	420.9		
		B300	300.3				
Rated hp. Constants: a = 2.684 b = 5.326 e = 0.0136		a = 4.737 c = 13.962 e = 0.0234		Rated hp. Constants: a = 8.792 c = 38.819 e = 0.0416		Rated hp. Constants: a = 18.788 c = 137.7 e = 0.0848	

SOME STOCK SHEAVE DIAMETERS

Varies by 0.2 in. from 2.6 through 5.2 in; then by 0.4 to 6.4; then 7, 8.2, 9, 10.6, 12, 15, 18 in.	Varies by 0.2 in. to 4.6; then 5, 5.2, 5.4, 5.6, 6, 6.4, 6.8, 7.4, 8.6, 9.4, 11, 12.4, 15.4, 18.4, 20, 25, 30, 38 in.	Varies by 0.5 in. from 7 to 11 in.; then by 1 to 14; by 2 to 20; then 24, 30, 36, 44, 50 in.	Varies by 0.5 in. from 13 to 16 in.; then 18, 22, 27, 33, 40, 48, 58 in.

TABLE 17.5 ARC-OF-CONTACT FACTORS, K_θ[17.13]

$\frac{D_2 - D_1}{C}$	K_θ VV	K_θ V-Flat
0.00	1.00	0.75
0.10	0.99	0.76
0.20	0.97	0.78
0.30	0.96	0.79
0.40	0.94	0.80
0.50	0.93	0.81
0.60	0.91	0.83
0.70	0.89	0.84
0.80	0.87	0.85
0.90	0.85	0.85
1.00	0.82	0.82
1.10	0.80	0.80
1.20	0.77	0.77
1.30	0.73	0.73
1.40	0.70	0.70
1.50	0.65	0.65

TABLE 17.4 SMALL-DIAMETER FACTORS K_d[17.11]

D_2/D_1	K_d
1.000–1.019	1.00
1.020–1.032	1.01
1.033–1.055	1.02
1.056–1.081	1.03
1.082–1.109	1.04
1.110–1.142	1.05
1.143–1.178	1.06
1.179–1.222	1.07
1.223–1.274	1.08
1.275–1.340	1.09
1.341–1.429	1.10
1.430–1.562	1.11
1.563–1.814	1.12
1.815–2.948	1.13
2.949 and over	1.14

TABLE 17.2 EXPERIENCE FACTORS

Type of Drive	C_a
Any except electric motor	1
Squirrel cage, compensator starting	0.67
Squirrel cage, line starting	0.5
Slip ring, and high starting torque	0.4

Pulley Size, in.	C_p
4 or less	0.5
$4\frac{1}{2}$ to 8	0.6
9 to 12	0.7
13 to 16	0.8
17 to 30	0.9
Over 30	1.0

Operating Conditions	C_f
Oily, wet or dusty atmosphere	0.74
Vertical drives	0.83
Jerky loads	0.83
Shock and reversing loads	0.71

LENGTH CORRECTION FACTORS K_L[17.11]

STD. LENGTH DESIG-NATION	BELT CROSS SECTION				
	A	B	C	D	E
26	0.81	..	..	..	..
31	0.84	..	..	..	..
35	0.87	0.81	..	..	..
38	0.88	0.83	..	..	..
42	0.90	0.85	..	..	..
46	0.92	0.87	..	..	..
51	0.94	0.89	0.80	..	..
55	0.96	0.90	..	..	..
60	0.98	0.92	0.82	..	..
68	1.00	0.95	0.85	..	..
75	1.02	0.97	0.87	..	..
80	1.04	..	..	..	..
81	..	0.98	0.89	..	..
85	1.05	0.99	0.90	..	..
90	1.06	1.00	0.91	..	..
96	1.08	..	0.92	..	..
97	..	1.02	..	..	..
105	1.10	1.04	0.94	..	..
112	1.11	1.05	0.95	..	..
120	1.13	1.07	0.97	0.86	..
128	1.14	1.08	0.98	0.87	..
144	..	1.11	1.00	0.90	..
158	..	1.13	1.02	0.92	..
173	..	1.15	1.04	0.93	..
180	..	1.16	1.05	0.94	0.91
195	..	1.18	1.07	0.96	0.92
210	..	1.19	1.08	0.96	0.94
240	..	1.22	1.11	1.00	0.96
270	..	1.25	1.14	1.03	0.99
300	..	1.27	1.16	1.05	1.01
330	..	..	1.19	1.07	1.03
360	..	..	1.21	1.09	1.05
390	..	..	1.23	1.11	1.07
420	..	..	1.24	1.12	1.09
480	..	..	..	1.16	1.12
540	..	..	..	1.18	1.14
600	..	..	..	1.20	1.17
660	..	..	..	1.23	1.19

TABLE 17.7 SERVICE FACTORS, K_s

Add 0.2 to the values given for each of the following conditions: continuous (over 16 hr/day) service; wet environment; idler in drive; speed-up drives. Subtract 0.2 if the operation is quite intermittent or seasonal. These factors represent compromises of those found in the literature, with the most attention to Refs. *(17.1, 17.11)*, and are primarily for V-belts; but they may serve as a guide for other transmission elements.

DRIVEN MACHINES	DRIVING MACHINES	
	Electric Motors *AC Split Phase* *AC Normal Torque Squirrel Cage, and Synchronous* *DC Shunt Wound* *Water Wheels* *Turbines, Steam and Water* *Internal Combustion Engines (Hydraulic Drive)*	*Electric Motors* *AC Single Phase Series Wound* *AC High Torque or High Slip* *AC Slip Ring* *AC Repulsion Induction* *AC Capacitor* *DC Compound Wound* *Steam Engines and Line Shafts* *Clutch on Driver or Driven Shaft*
Agitators, liquid Cam Cutters Conveyors, package Drill presses, Lathes Screw machines Small fans to 10 hp	1.1	1.2
Compressors and blowers, (rotating) Conveyors, ore, sand Generators Line Shafts Machine tools (other) Printing machinery Pumps (rotating) Shears	1.2	1.4
Ball mills Beaters (paper) Circular saws Compressors (recip.) Conveyors, bucket, apron, screw, drag Crushers, jaw, etc. Hammer mills Pulverizers Pumps (recip.) Punches, presses Propellers Revolving screens Tube mills	1.4	1.6
Hoists Mine fans Positive blowers Spinning frames Tumbling barrels Twisters (textile)	1.6	1.8

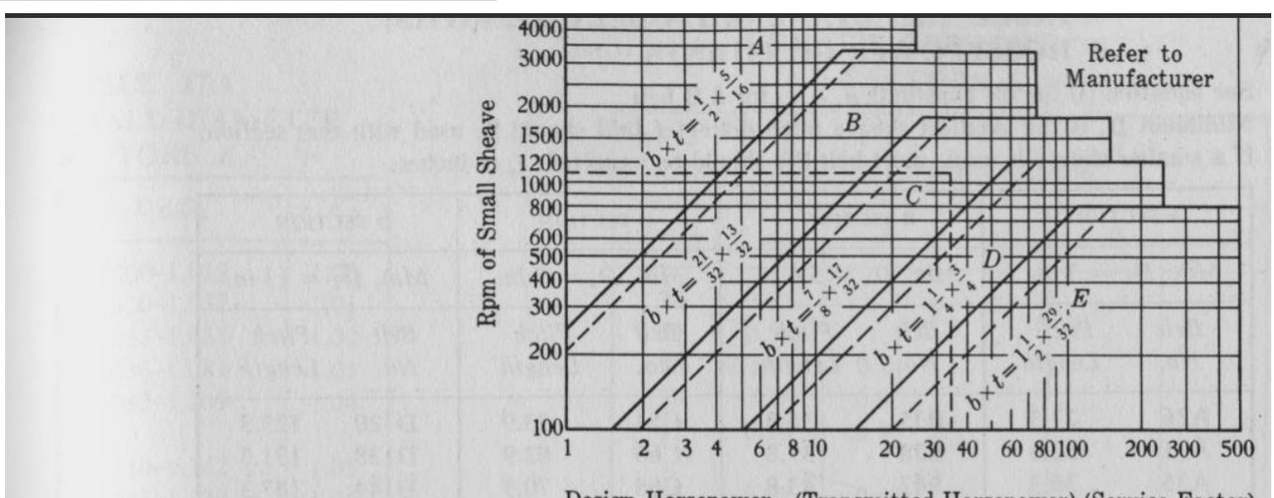

FIGURE 17.14 Belt Sections from Horsepower and Speed. The design horsepower is equal to the transmitted horsepower times the service factor. The solid diagonal lines are from ASA;[17.11] the dotted diagonal lines closely agree with more than one manufacturer's catalog.[17.13]

JOURNAL AND PLANE SURFACE BEARINGS

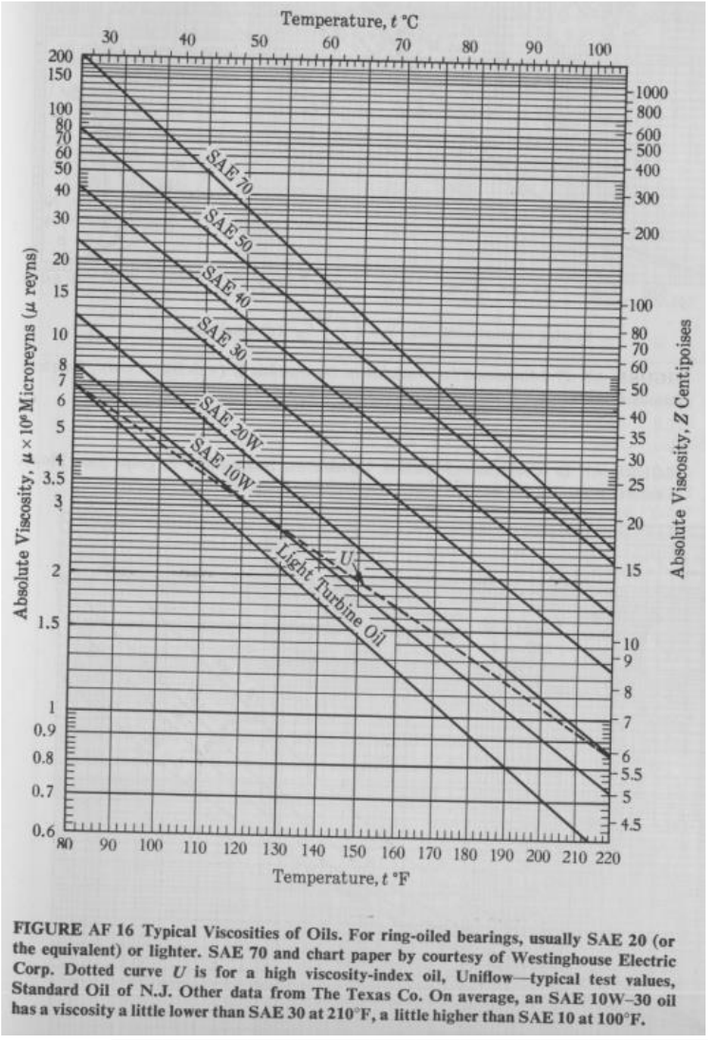

FIGURE AF 16 Typical Viscosities of Oils. For ring-oiled bearings, usually SAE 20 (or the equivalent) or lighter. SAE 70 and chart paper by courtesy of Westinghouse Electric Corp. Dotted curve *U* is for a high viscosity-index oil, Uniflow—typical test values, Standard Oil of N.J. Other data from The Texas Co. On average, an SAE 10W–30 oil has a viscosity a little lower than SAE 30 at 210°F, a little higher than SAE 10 at 100°F.

TABLE AT 20 DIMENSIONLESS PERFORMANCE PARAMETERS FOR FULL JOURNAL BEARINGS WITH SIDE FLOW

Courtesy Raimondi and Boyd[11.7] and Westinghouse Electric. Values of h_o/c_r for optimum bearings, maximum load and minimum friction, respectively: for $L/D = \infty$, 0.66, 0.60; for $L/D = 1$, 0.53, 0.30; for $L/D = 0.5$, 0.43, 0.12; for $L/D = 0.25$, 0.27, 0.03.

L/D	ϵ	$\frac{h_o}{c_r}$	S	ϕ	$\frac{r}{c_r}f$	$\frac{q}{rc_rn_sL}$	$\frac{q_s}{q}$	$\frac{\rho c\Delta t_o}{p}$	$\frac{p}{p_{max}}$
∞	0	1.0	∞	(70.92)	∞	π	0	∞	—
	0.1	0.9	0.240	69.10	4.80	3.03	0	19.9	0.826
	0.2	0.8	0.123	67.26	2.57	2.83	0	11.4	0.814
	0.4	0.6	0.0626	61.94	1.52	2.26	0	8.47	0.764
	0.6	0.4	0.0389	54.31	1.20	1.56	0	9.73	0.667
	0.8	0.2	0.021	42.22	0.961	0.760	0	15.9	0.495
	0.9	0.1	0.0115	31.62	0.756	0.411	0	23.1	0.358
	0.97	0.03	—	—	—	—	0	—	—
	1.0	0	0	0	0	0	0	∞	0
1	0	1.0	∞	(85)	∞	π	0	∞	—
	0.1	0.9	1.33	79.5	26.4	3.37	0.150	106	0.540
	0.2	0.8	0.631	74.02	12.8	3.59	0.280	52.1	0.529
	0.4	0.6	0.264	63.10	5.79	3.99	0.497	24.3	0.484
	0.6	0.4	0.121	50.58	3.22	4.33	0.680	14.2	0.415
	0.8	0.2	0.0446	36.24	1.70	4.62	0.842	8.00	0.313
	0.9	0.1	0.0188	26.45	1.05	4.74	0.919	5.16	0.247
	0.97	0.03	0.00474	15.47	0.514	4.82	0.973	2.61	0.152
	1.0	0	0	0	0	—	1.0	0	0
½	0	1.0	∞	(88.5)	∞	π	0	∞	—
	0.1	0.9	4.31	81.62	85.6	3.43	0.173	343.0	0.523
	0.2	0.8	2.03	74.94	40.9	3.72	0.318	164.0	0.506
	0.4	0.6	0.779	61.45	17.0	4.29	0.552	68.6	0.441
	0.6	0.4	0.319	48.14	8.10	4.85	0.730	33.0	0.365
	0.8	0.2	0.0923	33.31	3.26	5.41	0.874	13.4	0.267
	0.9	0.1	0.0313	23.66	1.60	5.69	0.939	6.66	0.206
	0.97	0.03	0.00609	13.75	0.610	5.88	0.980	2.56	0.126
	1.0	0	0	0	0	—	1.0	0	0
¼	0.0	1.0	∞	(89.5)	∞	π	0	∞	—
	0.1	0.9	16.2	82.31	322.0	3.45	0.180	1287.0	0.515
	0.2	0.8	7.57	75.18	153.0	3.76	0.330	611.0	0.489
	0.4	0.6	2.83	60.86	61.1	4.37	0.567	245.0	0.415
	0.6	0.4	1.07	46.72	26.7	4.99	0.746	107.0	0.334
	0.8	0.2	0.261	31.04	8.80	5.60	0.884	35.4	0.240
	0.9	0.1	0.0736	21.85	3.50	5.91	0.945	14.1	0.180
	0.97	0.03	0.0101	12.22	0.922	6.12	0.984	3.73	0.108
	1.0	0	0	0	0	—	1.0	0	0

q in.³/sec. $\rho \approx 0.03$ lb/in.³ $c = 3734$ in–lb/lb–°F. $\rho c = 112$.

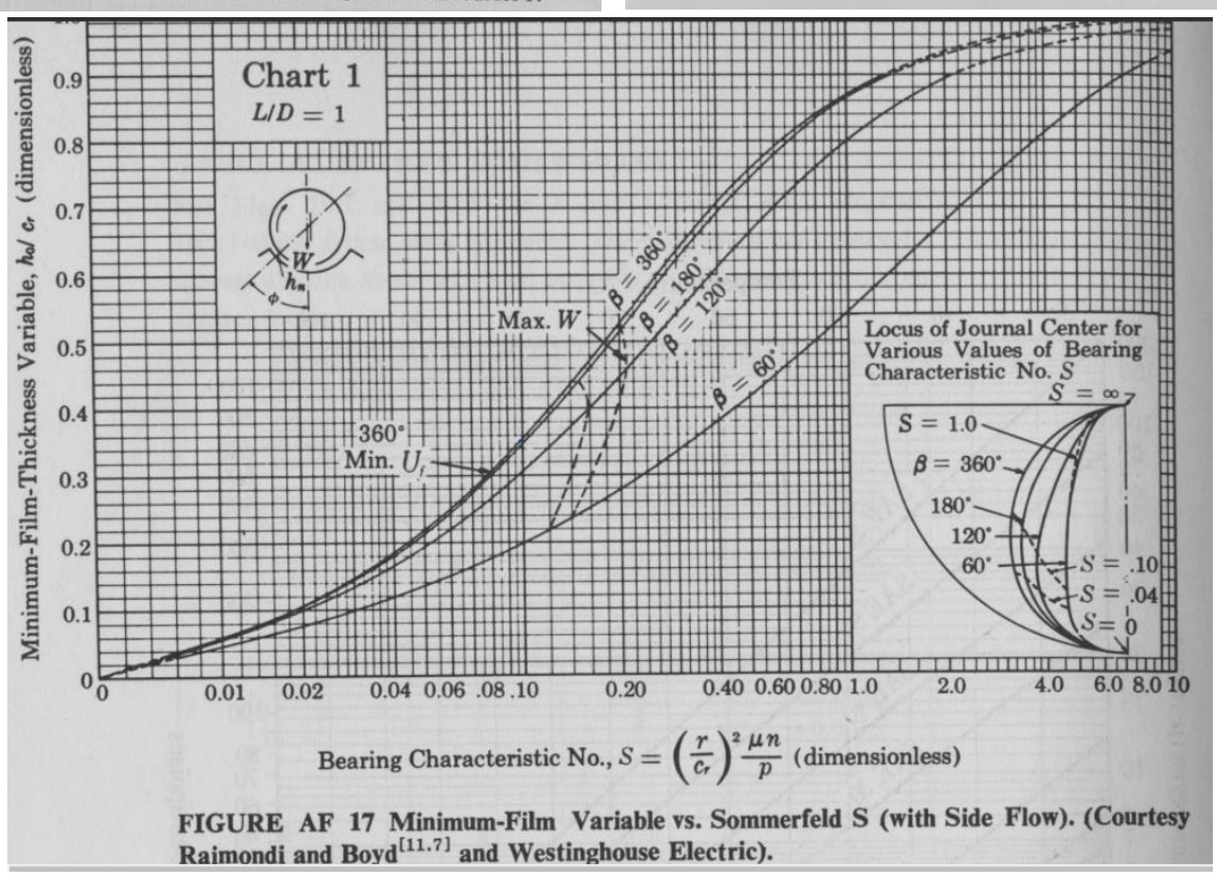

FIGURE AF 17 Minimum-Film Variable vs. Sommerfeld S (with Side Flow). (Courtesy Raimondi and Boyd[11.7] and Westinghouse Electric).

FIGURE AF 18 Coefficient-of-Friction Variable vs. Sommerfeld S (with Side Flow). (Courtesy Raimondi and Boyd[11.7] and Westinghouse Electric).

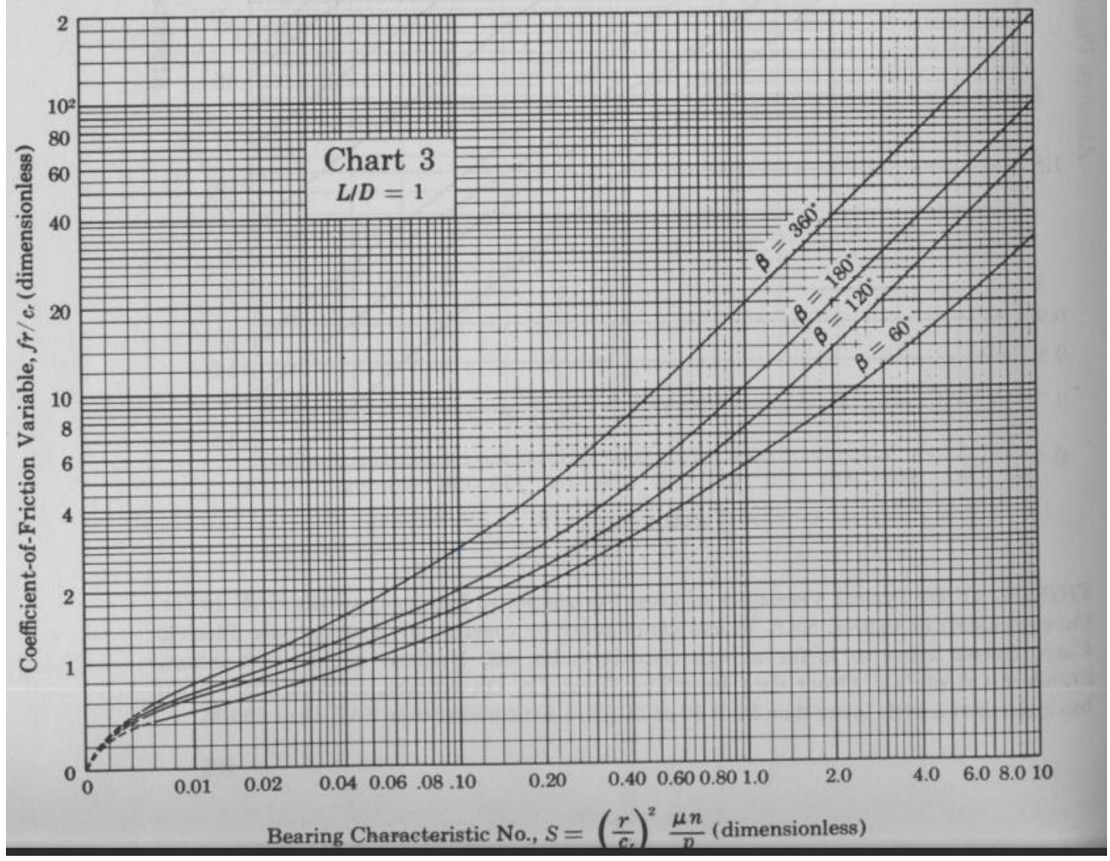

TABLE AF 21 DIMENSIONLESS PERFORMANCE PARAMETERS FOR 180° BEARING, CENTRALLY LOADED, WITH SIDE FLOW

Courtesy Raimondi and Boyd[11.7] and Westinghouse Electric. Values of h_o/c_r for optimum bearings, maximum load and minimum friction, respectively: for $L/D = \infty$, 0.64, 0.6; for $L/D = 1$, 0.52, 0.44; for $L/D = 0.5$, 0.42, 0.23; for $L/D = 0.25$, 0.28, 0.03.

L/D	ϵ	$\frac{h_o}{c_r}$	S	ϕ	$\frac{r}{c_r}f$	$\frac{q}{rc_rn_sL}$	$\frac{q_s}{q}$	$\frac{\rho c\Delta t_o}{p}$	$\frac{p}{p_{max}}$
∞	0	1.0	∞	90.0	∞	π	∞	∞	—
	0.1	0.9	0.347	72.90	3.55	3.04	0	14.7	0.778
	0.2	0.8	0.179	61.32	2.01	2.80	0	8.99	0.759
	0.4	0.6	0.0898	49.99	1.29	2.20	0	7.34	0.700
	0.6	0.4	0.0523	43.15	1.06	1.52	0	8.71	0.607
	0.8	0.2	0.0253	33.35	0.859	0.767	0	14.1	0.459
	0.9	0.1	0.0128	25.57	0.681	0.380	0	22.5	0.337
	0.97	0.03	0.00384	15.43	0.416	0.119	0	44.0	0.190
	1.0	0	0	0	0	0	0	∞	0
1	0	1.0	∞	90.0	—	π	0	∞	—
	0.1	0.9	1.40	78.50	14.1	3.34	0.139	57.0	0.525
	0.2	0.8	0.670	68.93	7.15	3.46	0.252	29.7	0.513
	0.4	0.6	0.278	58.86	3.61	3.49	0.425	16.5	0.466
	0.6	0.4	0.128	44.67	2.28	3.25	0.572	12.4	0.403
	0.8	0.2	0.0463	32.33	1.39	2.63	0.721	10.4	0.313
	0.9	0.1	0.0193	24.14	0.921	2.14	0.818	9.13	0.244
	0.97	0.03	0.00483	14.57	0.483	1.60	0.915	6.96	0.157
	1.0	0	0	0	0	—	1.0	0	0
$\frac{1}{2}$	0	1.0	∞	90.0	∞	π	0	∞	—
	0.1	0.9	4.38	79.97	44.0	3.41	0.167	177.0	0.518
	0.2	0.8	2.06	72.14	21.6	3.64	0.302	87.8	0.499
	0.4	0.6	0.794	58.01	9.96	3.93	0.506	42.7	0.438
	0.6	0.4	0.321	45.01	5.41	3.93	0.665	25.9	0.365
	0.8	0.2	0.0921	31.29	2.54	3.56	0.806	15.0	0.273
	0.9	0.1	0.0314	22.80	1.38	3.17	0.886	9.80	0.208
	0.97	0.03	0.00625	13.63	0.581	2.62	0.951	5.30	0.132
	1.0	0	0	0	0	—	1.0	0	0
$\frac{1}{4}$	0	1.0	∞	90.0	∞	π	0	∞	—
	0.1	0.9	16.3	81.40	163.0	3.44	0.176	653.0	0.513
	0.2	0.8	7.60	73.70	79.4	3.71	0.320	320.0	0.489
	0.4	0.6	2.84	58.99	35.1	4.11	0.534	146.0	0.417
	0.6	0.4	1.08	44.96	17.6	4.25	0.698	79.8	0.336
	0.8	0.2	0.263	30.43	6.88	4.07	0.837	36.5	0.241
	0.9	0.1	0.0736	21.43	2.99	3.72	0.905	18.4	0.180
	0.97	0.03	0.0104	12.28	0.877	3.29	0.961	6.46	0.110
	1.0	0	0	0	0	—	1.0	0	0

TABLE AF 22 DIMENSIONLESS PERFORMANCE PARAMETERS FOR 120° BEARING, CENTRALLY LOADED, WITH SIDE FLOW.

Courtesy Raimondi and Boyd[11.7] and Westinghouse Electric. Values of h_o/c_r for optimum bearings, maximum load and minimum friction, respectively: for $L/D = \infty$, 0.53, 0.5; for $L/D = 1$, 0.46, 0.4; for $L/D = 0.5$, 0.38, 0.28; for $L/D = 0.25$, 0.26, 0.06. When $1 - h_o/c_r \neq \epsilon$, the trailing end of the bearing does not reach h_o as defined in Fig. 11.6; that is, h_o in this table is h_{min}.

L/D	ϵ	$\frac{h_o}{c_r}$	S	ϕ	$\frac{r}{c_r}f$	$\frac{q}{rc_rn_sL}$	$\frac{q_s}{q}$	$\frac{\rho c\Delta t_o}{p}$	$\frac{p}{p_{max}}$
∞	0	1.0	∞	90.0	∞	π	0	∞	—
	0.1	0.9007	0.877	66.69	6.02	3.02	0	25.1	0.610
	0.2	0.8	0.431	52.60	3.26	2.75	0	14.9	0.599
	0.4	0.6	0.181	39.02	1.78	2.13	0	10.5	0.566
	0.6	0.4	0.0845	32.67	1.21	1.47	0	10.3	0.509
	0.8	0.2	0.0328	26.80	0.853	0.759	0	14.1	0.405
	0.9	0.1	0.0147	21.51	0.653	0.388	0	21.2	0.311
	0.97	0.03	0.00406	13.86	0.399	0.118	0	42.4	0.199
	1.0	0	0	0	0	0	0	∞	0
1	0	1.0	∞	90.0	∞	π	0	∞	—
	0.1	0.9024	2.14	72.43	14.5	3.20	0.0876	59.5	0.427
	0.2	0.8	1.01	58.25	7.44	3.11	0.157	32.6	0.420
	0.4	0.6	0.385	43.98	3.60	2.75	0.272	19.0	0.396
	0.6	0.4	0.162	35.65	2.16	2.24	0.384	15.0	0.356
	0.8	0.2	0.0531	27.42	1.27	1.57	0.535	13.9	0.290
	0.9	0.1	0.0208	21.29	0.855	1.11	0.657	14.4	0.233
	0.97	0.03	0.00498	13.49	0.461	0.694	0.812	14.0	0.162
	1.0	0	0	0	0	—	1.0	0	0
$\frac{1}{2}$	0	1.0	∞	90.0	∞	π	0	—	—
	0.1	0.9034	5.42	74.99	36.6	3.29	0.124	149.0	0.431
	0.2	0.8003	2.51	63.38	18.1	3.32	0.225	77.2	0.424
	0.4	0.6	0.914	48.07	8.20	3.15	0.386	40.5	0.389
	0.6	0.4	0.354	38.50	4.43	2.80	0.530	27.0	0.336
	0.8	0.2	0.0973	28.02	2.17	2.18	0.684	19.0	0.261
	0.9	0.1	0.0324	21.02	1.24	1.70	0.787	15.1	0.203
	0.97	0.03	0.00631	13.00	0.550	1.19	0.899	10.6	0.136
	1.0	0	0	0	0	—	1.0	0	0
$\frac{1}{4}$	0	1.0	∞	90.0	∞	π	0	∞	—
	0.1	0.9044	18.4	76.97	124.0	3.34	0.143	502.0	0.456
	0.2	0.8011	8.45	65.97	60.4	3.44	0.260	254.0	0.438
	0.4	0.6	3.04	51.23	26.6	3.42	0.442	125.0	0.389
	0.6	0.4	1.12	40.42	13.5	3.20	0.599	75.8	0.321
	0.8	0.2	0.268	28.38	5.65	2.67	0.753	42.7	0.237
	0.9	0.1	0.0743	20.55	2.63	2.21	0.846	25.9	0.178
	0.97	0.03	0.0105	12.11	0.832	1.69	0.931	11.6	0.112
	1.0	0	0	0	0	—	1.0	0	0

TABLE AT 23 DIMENSIONLESS PERFORMANCE PARAMETERS FOR 60° BEARING, CENTRALLY LOADED, WITH SIDE FLOW

Courtesy Raimondi and Boyd[11.7] and Westinghouse Electric. Values of h_o/c_r for optimum bearings, maximum load and minimum friction, respectively: for $L/D = \infty$, 0.25, 0.23; for $L/D = 1$, 0.23, 0.22; for $L/D = 0.5$, 0.2, 0.16; for $L/D = 0.25$, 0.15, 0.1. When $1 - h_o/c_r \neq \epsilon$, the trailing end of the bearing does not reach h_o as defined in Fig. 11.6; that is, h_o in this table is h_{min}.

L/D	ϵ	$\frac{h_o}{c_r}$	S	ϕ	$\frac{r}{c_r}f$	$\frac{q}{rc_r n_s L}$	$\frac{q}{q_s}$	$\frac{\rho c \Delta t_o}{p}$	$\frac{p}{p_{max}}$
∞	0	1.0	∞	90.0	∞	π	0	∞	—
	0.1	0.9191	5.75	65.91	19.7	3.01	0	82.3	0.337
	0.2	0.8109	2.66	48.91	10.1	2.73	0	46.5	0.336
	0.4	0.6002	0.931	31.96	4.67	2.07	0	28.4	0.329
	0.6	0.4	0.322	23.21	2.40	1.40	0	21.5	0.317
	0.8	0.2	0.0755	17.39	1.10	0.722	0	19.2	0.287
	0.9	0.1	0.0241	14.94	0.667	0.372	0	22.5	0.243
	0.97	0.03	0.00495	10.58	0.372	0.115	0	40.7	0.163
	1.0	0	0	0	0	0	0	∞	0
1	0	1.0	∞	90.0	∞	π	0	∞	—
	0.1	0.9212	8.52	67.92	29.1	3.07	0.0267	121.0	0.252
	0.2	0.8133	3.92	50.96	14.8	2.82	0.0481	67.4	0.251
	0.4	0.6010	1.34	33.99	6.61	2.22	0.0849	39.1	0.247
	0.6	0.4	0.450	24.56	3.29	1.56	0.127	28.2	0.239
	0.8	0.2	0.101	18.33	1.42	0.883	0.200	22.5	0.220
	0.9	0.1	0.0309	15.33	0.822	0.519	0.287	23.2	0.192
	0.97	0.03	0.00584	10.88	0.422	0.226	0.465	30.5	0.139
	1.0	0	0	0	0	—	1.0	0	0
$\frac{1}{2}$	0	1.0	∞	90.0	∞	π	0.0	∞	—
	0.1	0.9223	14.2	69.00	48.6	3.11	0.0488	201.0	0.239
	0.2	0.8152	6.47	52.60	24.2	2.91	0.0883	109.0	0.239
	0.4	0.6039	2.14	37.00	10.3	2.38	0.160	59.4	0.233
	0.6	0.4	0.695	26.98	4.93	1.74	0.236	40.3	0.225
	0.8	0.2	0.149	19.57	2.02	1.05	0.350	29.4	0.201
	0.9	0.1	0.0422	15.91	1.08	0.664	0.464	26.5	0.172
	0.97	0.03	0.00704	10.85	0.490	0.329	0.650	27.8	0.122
	1.0	0	0	0	0	—	1.0	0	0
$\frac{1}{4}$	0	1.0	∞	90.0	∞	π	0	∞	—
	0.1	0.9251	35.8	71.55	121.0	3.16	0.0666	499.0	0.251
	0.2	0.8242	16.0	58.51	58.7	3.04	0.131	260.0	0.249
	0.4	0.6074	5.20	41.01	24.5	2.57	0.236	136.0	0.242
	0.6	0.4	1.65	30.14	11.2	1.98	0.346	86.1	0.228
	0.8	0.2	0.333	21.70	4.27	1.30	0.496	54.9	0.195
	0.9	0.1	0.0844	16.87	2.01	0.894	0.620	41.0	0.159
	0.97	0.03	0.0110	10.81	0.713	0.507	0.786	29.1	0.107
	1.0	0	0	0	0	—	1.0	0	0